

Network Interference Server

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Proposed New Methods

- **Open Access**

- [Noam, Benkler, Shepard, Reed]
- Agile radios will dynamically share a commons

- **Spectrum Property Rights**

- [Coase ... Hazlett, Faulhaber+Farber]
- Owners can buy/sell/trade spectrum
- Flexible use, flexible technology, flexible divisibility, transferability

Spectrum Research Opportunity or Dilemma?

- Approaches/methods/solutions depend strongly on radio technology
- Technical Approaches in this project:
 - Friedman: IT + Cooperation
 - Spasojevic: Complex Coding
 - Rose: Adaptive transmitters
 - Mandayam: Wideband transmission by energy constrained devices
- Dilemma:
 - Focus on practice or fundamental theory?

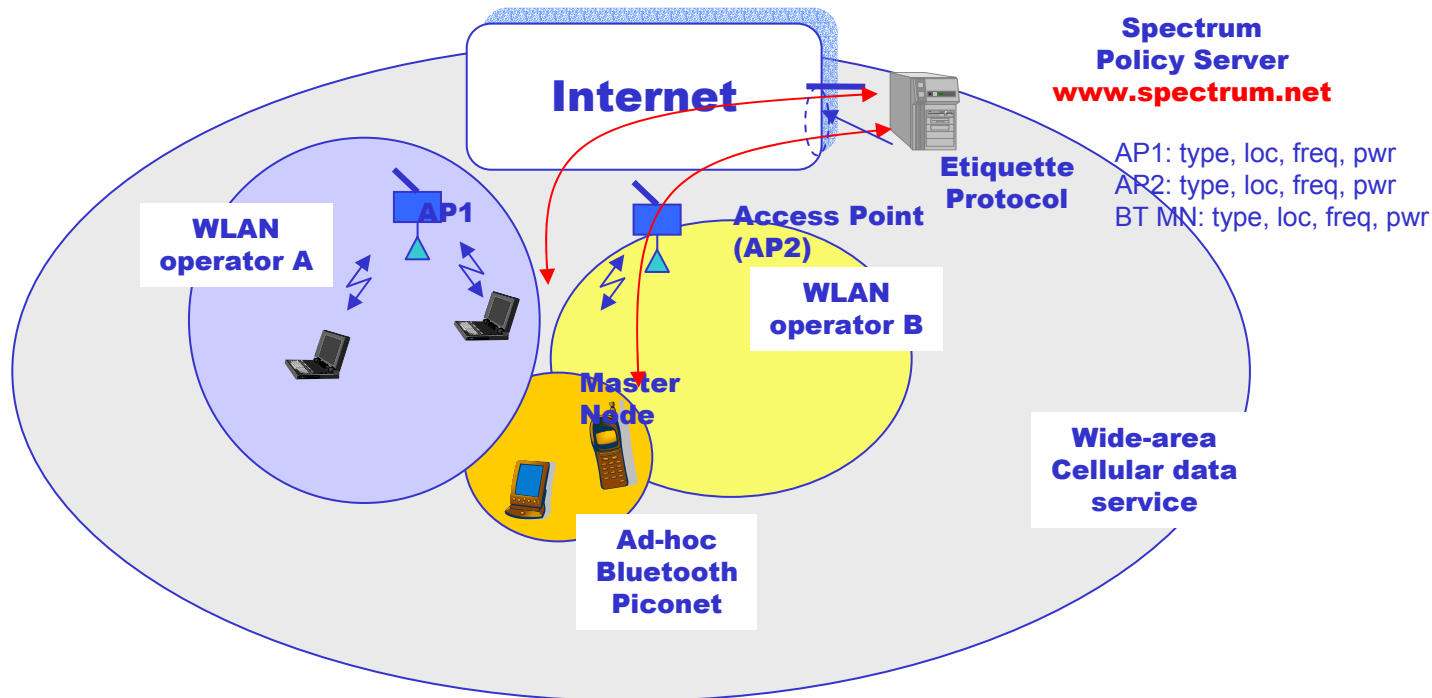
Internet Motivation

- Few technology assumptions
 - Links carry bits.
 - Routers forward packets
 - Users get an IP address, gateway, nameserver addresses
 - Applications “interfere” in the network
- Network is useful despite (because of?) simplicity
 - “TCP-like” solutions

Internet Spectrum Policy Server

Internet-based Spectrum Policy Server can help to coordinate wireless networks

- needs connection to Internet even under congested conditions (...low bit-rate OK)
- some level of position determination needed (...coarse location OK)
- spectrum coordination achieved via etiquette protocol centralized at server



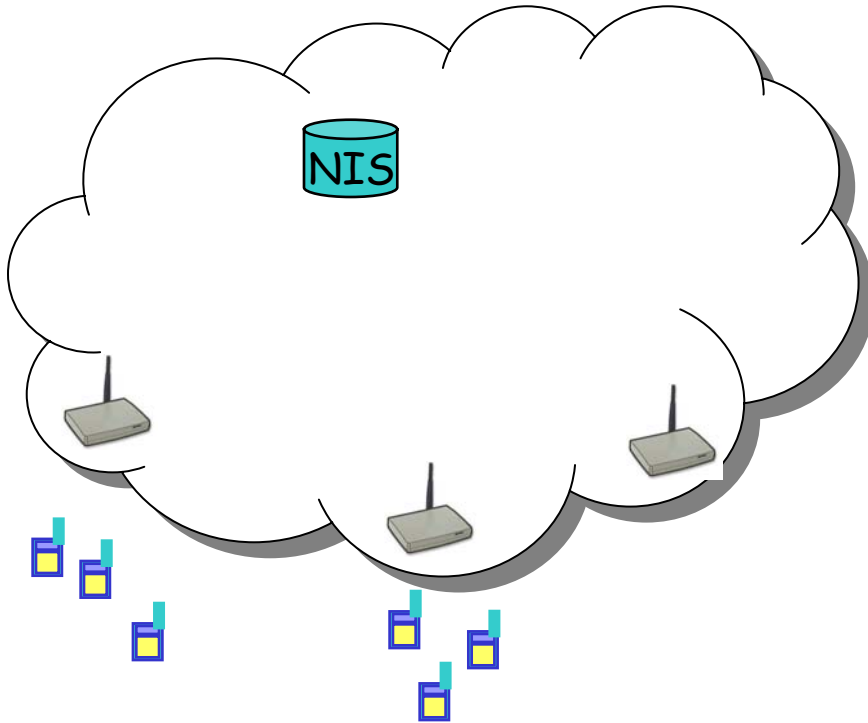
Network Interference Server (NIS)

[Project with S.C. Mau, R. Roy]

- **Goals**

- Use coarse measurements to identify spectrum users and facilitate sharing
- Avoid radio technology assumptions.
 - Users can listen
 - Users have clocks
 - Users have low bit rate IP access
 - Users may **not** understand each others radio transmissions

NIS Methodology



- New users get an NIS address
 - Analogous to DNS nameserver address
- Users send activity traces to NIS server
- NIS maintains database of activity traces

Coarse Activity Traces

- Packet Time Scale
- Slotted Time
 - Slot time ≥ 1 ms
- 1 Bit Feedback per Slot
 - Tx ON or OFF
 - Traces generate < 1 kb/s
- Traces over 10 sec:
 - Random vectors, length 10,000

Measurement Traces

- **Nodes:**
 - make measurement traces
 - received power measurements in each slot
 - measurement traces sent to NIS
- **NIS:**
 - searches database for correlated activity traces
 - Notifies nodes of signal space neighbors

NIS Philosophy

- “Don’t worry about invisible aliens”
 - “Interference” may be orthogonal to measurements
 - Example: UWB for 802.11
 - A measurement trace is a projection of all signals onto the signal subspace the node can measure.
- Incentives for invisibility?

NIS Potential Actions

- Share wireless node descriptors?
 - From wireless node descriptor database
- Coordinate comm. between nodes?
 - Application layer protocol for communication between nodes hidden from each other
 - No need for common radio signaling
- Mediate spectrum sharing among nodes?

NIS Issues

- Coarseness of measurements?
 - Activity trace resolution 1 μ s, 1ms, 1s ?
- Activity trace update frequency?
- NIS database compression/searching
 - Organizing traces to save space, facilitate fast searches.